09/889997

JC17 Rec'd PCT/PTO 2 3 JUL 2001

Inventors: Michael BECKER
Hennig WÖHLER

Invention: METHOD FOR DETERMINING COEFFICIENTS CHARACTERISTIC OF THE OPTICAL BEHAVIOR OF LIQUID CRYSTAL CELLS

Attorney's Docket Number: MEL201

Horst M. Kasper, their attorney
13 Forest Drive, Warren, N.J. 07059
Tel. (908)526 1717; Reg. No. 28559
Attorney's Docket No.: MEL201

ENGLISH TRANSLATION OF
INTERNATIONAL PCT APPLICATION

Application No. : PCT/EP99/00377
Filing Date : January 21, 1999

3 | PRTS

09/889997
JC17 Rec'd PCT/PTO 23 JUL 2001

Method for determining coefficients characteristic of the optical behavior of liquid crystal cells

The invention relates to a method according to the preamble of the claim 1.

Such a method is known from the German printed patent document DE-A-40 11 116 for determining the tilt angle (of these so-called pre-tilt angle or tilt bias angle) at the two boundary layers of the liquid crystal dispose opposite and planar parallel to each other relative to the orientation layers on the electrode coated cell glasses of liquid crystal cell (liquid crystal display, LCD) with a non-spiral texture. A dichroic dye is added to a test cell to be investigated as well as to a separately furnished, equally constructed comparison cell, which however comprises an iso-tropic host material in each case in such an amount that finally the same absorption is set in the two cells according to that method. The two cells are then transilluminated in parallel to each other by polarized light. The influence of interfering accompanying effects is to be compensated by the employment of the comparison cell in order to be able to more easily localize the extreme value

of the transmission depending on the angle of irradiation by the test cell. The transmission curve course caused by the absorption is monotonous over the angle of incidence of the light, the transmission curve course exhibits usually only one extreme and no local maxima and minima staggered relative to each other.

It is however already possible only under very large difficulties to achieve the same initial absorption by dye addition in two cells cause the aligned state and the iso-tropic state do not behave equally from the beginning. In addition such dye absorptions influence the physical properties and thus the behavior of the liquid crystal structure, which alone is of interest. It is to be added that with the absorption -- extreme value search described there in detail only tilt angles in twist free thick cells (namely in the order of magnitude above 20 micrometers layer thickness of the liquid crystal) can be captured -- and this only then, in the edge tilt angle is disposed in a fairly limited region around precisely parallel or around perpendicular orientation relative to the glass boundary layer. The layer thickness of liquid crystal display cells as they are produced to date in production lines however is

dispose in an order of magnitude less, that is namely at about four micrometers to five micrometers. No cells withdrawn from the running production can be checked with respect to maintaining of a desired tilt angle according to this method because functioning, taxable cells are already closed (adhesively attached) such that a following successive addition of dye is now prohibited. This previously known method with specially prepared thick liquid crystal cells swiveled around an axis in the test team is thus not suitable for a measurement purposes and full control purposes in a practical situation, such as et real cells and in real-time under continuous production.

It can however be shown, that the position or, respectively, the displacement of a symmetry angle can be employed as a measure for the boundary layer tilt angle on the orientation layer for the liquid crystal molecules in the cell, wherein the symmetry angle is caused by angle of incidence depending effects of the birefringence, that is by changes of the transmission over the angle of the incidence of the light of a thick testing cell swiveled in the test been between crossed polarizers with a non-helical liquid crystal texture. The edge tilt angle of interest can be calculated then from a symmetry offset

angle displacement measured out of the course of the curve the symmetry offset angle displacement represents the shifting offer symmetry point between two successive uniformly directed extreme values out of the coordinate zero axis depending on the crystal rotation in the test beam. It has however to be considered in connection with this crystal rotation measurement method that a geometric rigorous symmetry in the course of the curve is in fact given only in case of a symmetry point not shifted out of the zero axis (Y-- axis), that is in connection with an imperceptible small edge tilt angle in the cell. Only in this case is the y-axis also the symmetry axis of the transmission distribution. The symmetry is distorted outside of the coordinate zero point. It is in particular annoying in the industrial practice that again first to thick testing cell (with a typical glass plate distance of more than 20 micrometers) has to be produced for the geometric measurement of the position of the shifted symmetry axis, such that thereby in fact a certain production technology can be judged, however also such a method is not applicable to some books of running production, that is to the thin in reality produced display cells.

It can be shown experimentally and also by numeric model calculations that the two extreme values, between which the searched for (pseudo) symmetry axis is dispose according to a giving of a measurement for the size of the edge tilt angle in the cell shifted out of the y-axis of the coordinate system, wherein the two extreme values move always further apart from each other with the liquid crystal layer becoming thinner. The regular extrema of the double reflection modulated transmission finally migrate out of the angle region which is still can be covered by the light beam, with decreasing thickness of the liquid crystal layer. A very thin liquid crystal layer entails only a very weak modulated course of the measurement curve, which course of the measurement curve can be explained as a section out of the transmission course of a thick cell. The pseudo symmetry axis itself also leaves the irradiation angle region which is a capable of being covered by the light beam, with the larger becoming edge tilt angle. However larger scanning measurement regions that about plus/minus 70 degrees incidence angle of the light are hardly realizable in practically realizable geometries for apparatus reasons and therewith symmetry offsets occurring at edge tilt angles all the more than about 13 degrees already cannot any longer be

captured experimentally.

At any rate the shifted, relative to the situation with a perpendicular incidence of light, or pseudo symmetry value is not any longer unequivocally bindable based on a lack of framing extreme or in the captured measurement course of the irradiation angle dependent transmission through a thin cell. Is to be added that, as can be shown, in case of very thin cells (about around five micrometers and less) and in case of a small angle of incidence of the beam, then increasingly the transmission course is increasingly superposed by in a certain sense `high frequent `appearing intensity variations of the transmission, wherein the intensity variations of the transmission are to be traced to interferences of multiple reflections depending on the angle of irradiation at the boundary faces between the cell glasses and the surrounding air. To this noise related effect, which already very much renders difficult the geometric evaluation of the measured to transmission course through a thinner cell, they are than also still superposed less `high frequent` interference appearances over the beam angle of incidence, wherein the less `high frequent` interference appearances

are generated by angle dependent multiple reflections in the liquid crystal layer itself. Furthermore influences of the transparent electrodes onto the internal cell glass faces can be edited, wherein the internal cell glass faces comprise indium tin oxide (ITO) with a particularly high optical index of refraction, wherefore intensely partial reflections can be generated here.

Such modulations superposed to the properly interesting measurement course occur in fact principally also in connection with the thick cells, however there the additional effects are hardly noticeable based on high frequencies and low amplitudes in comparison to the double reflection modulations, the superposed modulations however do not interfere with the evaluation. In case of a thin cell in contrast a curve course interfered with such modulations just in the region of the zero point surrounding (in case of a small offset of the `symmetry angle` based on small values of the (edge) tilt angle on the orientation layer in the interior of the cell) is only with difficulties or not at all any longer unequivocally evaluable.

Recognizing these limiting facts, it is an object of the present invention to

create a comparably quickly performable and also substantially automatizable, high resolving as well as reproducible characteristic value determination at real liquid crystal cells are to small cell thickness and with edge tilt angles occurring over the full region of the production practice (that is between the zero and 90 degrees relative to the orientation covered glass surface) also a determination further characterizing values decisive for the electro-optical behavior of the cell going beyond there over the determination of this tilt angle of the molecule such as in particular the layer thickness of the liquid crystal.

This object is accomplished according to the main claim by now completely dispensing with edge geometric measurement of the position of a symmetry point in the transmission course measured under crystal rotation. In accordance with the present invention instead and in addition to a pure picking up of the transmission course depending on the tilt angle, a transmission curve is calculated for at least the behavior of the liquid crystal in the cell depending on the double refraction and wherein so long again and again and renewed calculation is performed with it changed characteristic

values until the actual input value of at least one determined characteristic value, among then the really searched for characteristic value, the courses of the two curves sufficiently well coincide; wherein in addition to the effects of the double refraction also the effects of the multiple reflections in the liquid crystal layer can be taken into consideration in the model calculation for improving the adaptation quality, in the simpler model calculation otherwise does not really lead to success with respect to the geometric adaptation to the measurement course based on a cell too thin. The parasitic interferences, which can render impossible to geometric evaluation of a measured course just in case of a thin cell do not any longer at all interfere in this adaptation of measured and calculated curve courses, since also still certain other influences such as in particular those based on multiple reflections enter into the model calculation for the modulations of the transmission curve beyond the influences of the double refraction, however the further interfering modulations still superposed in the measurement course are simply not take into consideration in the mathematical model for the adaptation curve. The modulations possibly to be taken into consideration in addition, based on multiple reflections in the liquid crystal

material, exhibit in fact a stronger dependence on the layer thickness of the liquid crystals based on their comparably small modulation (above the angle of incidence of the light), however the modulations are also depending on the primary interesting tilt angle, wherefore the consideration of the tilt angle in addition to the dominating modulations by double refraction in the transmission calculation is reasonable and leads to reliable results. If however the thickness of the liquid crystal layer is not precisely known from other kind of measurements, but is assumed to have a false value, then the change of the tilt angle input alone cannot lead to a core result, then there is required to an iterative adaptation also of the layer thickness. Advantageously in case of the purely birefringence caused modulation, the thickness and the tilt angle of the liquid crystal layer are treated simultaneously as variables. The decisive thickness of the liquid crystal layer for the modulation effects by double refraction can be derived from the results of the model curve calculation adapted to the measured course together with the tilt angle on the orientation layer.

In order to determine the transmission course also in a thin liquid crystal

cell, for example the liquid crystal cell taken from the running production, according to the present invention therefore for the first time transmission modulations are taking into consideration, wherein the transmission modulations are based on multiple reflections in the liquid crystal layer. The transmission curve attainable from the model calculation, which comprises at any rate the modulations caused by double reflection and full very thin cells than also at least the modulations caused by multiple reflections in the liquid crystal layer, is numerically adapted to the three given transmission curve course since measured in reality. The free parameters of interest are varied iteratively so long until an optimum quantitative correspondence is obtained between the measured course of the transmission and the curve of the transmission calculated without the influence of interfering modulations components as a function of the angle of incidence of the light. The parameter value to be varied for the numeric adaptation of a curve calculated with the optical model to the course measured by the cell itself is also in particular the tilt angle on the orientation layer in the cell. In case the thickness of the liquid crystal layer is not known with a sufficient precision, for example from a different independent measurement, then the thickness of

the liquid crystal layer can also be systematically varied in the model calculation in order to reach a good adaptation between measurement and calculation, from which then a conclusion as to the thickness can be made. However those parameters, for which parameters there is set just an optimum adaptation of the calculated curve to the measured course, are the searched for information above the real construction of the considered cell of in principal arbitrary, however in particular also very small thickness of its liquid crystal layer. It can be accepted in this context without further consideration that only the actual tilt bias angle or edge tilt bias angle for non-helical structures can be determined exactly. Since the tilt angle is a function of the location of the liquid crystal layer in the general case of helical structures, each measurement method, which employs a light beam transmitted through the complete liquid crystal layer as a sonde or probe, gives only an average value of the tilt angle over the thickness of the liquid crystal layer. This average value is however completely sufficient in practice for production control of the today employed liquid crystal displays, which liquid crystal displays are based mainly on the twisted nematic effect (TN-cells) or on the super twisted nematic effect (STN-cells), therefore do

not exhibit a helical free liquid crystal layer but instead exhibit a helical structure in their molecular arrangements.

For the case that the cell is swivelable relative to the spatially fixed light beam in the conventional way for receiving of the transmission course relative to the angle of incidence of the beam, then the solution according to the present invention can be realized for the determination of the searched for solution now for the first time in a measurement range unlimited between zero and 90 degrees for the searched for characterizing value `tilt angle` in contrast to the practically given limitation with respect to angle in the graphic geometric evaluation of a measurement curve. Instead -- and in this respect more simple with respect to apparatus construction -- a `crystal rotation` for capturing the course of the measurement can also be realized by having the cell also stationarily disposed, namely between a stationary source for monochromatic light and a lens with a particularly high opening ratio, and here with a cell normal oriented parallel to the optical axis of the lens in the front lens focal plane. The cell is convergently transmitted at the respective measurement pouring from the rear side disposed opposite, for

example by an extended diffuse source or by a convergent beam focused in a measurement point. An intensity distribution occurs thereby according to the conoscopic principal (such as is for example explained in more detail in the printed German patent document DE 19602862 C1), wherein the intensity distribution exhibits the in principal same intensity modulation depending on the angle of passage of the beam over a dye matter lying parallel relative to the orientation of the optical axis of the liquid crystal, as does exhibit the course measured according to the principal of the mechanical rotation. The numerical aperture of the lens or, respectively, the conoscopic lens system naturally determines the limits of the angle, under which angle the light can transmit the cell, in this stationary arrangement.

Additional details and further developments of the invention result from the sub claims and from the following description of the drawings. The method is symbolically and simplified sketched in the drawings by way of the performance of the method. There is shown in:

Figure 1 a measurement set up with a rotating cell in principal,

Figure 2 a stationary measurement set up with conoscopic technology in principal, and

Figure 3 at typical measurement course through a thin cell as well as a calculated transmission curve already well adapted and modulated by birefringence and superposed to the typical measurement course as well as a calculated curve of the transmission modulations still not adapted in detail but under consideration of also multiple reflections in the liquid crystal layer.

The liquid crystal cell 11 to be investigated and to be removed immediately from the running production can be supported about on the revolving stage 12 for its bodily swiveling relative to a stationary light source 13 for capturing of the course of the transmission 17 and the liquid crystal cell 11 can be impinged with a collimated test beam 14 (for example a laser beam) from the source 13 under variable angle of incidence of the light w (figure 1); or the beam 14 is swiveled relative to a stationary cell 11. Here the

swivel axis is always oriented perpendicular to the plane, in which plane the optical axis of the non-helical liquid crystal is disposed; whereas in contrast the swivel axis of a helical configuration stands perpendicular to the plane of the angle bisector of the helix, that is perpendicular to that plane wherein the optical axis of the liquid crystal is lying in the middle of the helical liquid crystal layer. The precise swivel angle zero position (w=0) of the perpendicular incidence of light onto the cell 11 is determined advantageously based on the back reflection from the cell 11 itself onto an angle selective detector 26, wherein the angle selective detector to 6 for example is disposed spatially fixed in a known angle position w relative to the test beam 14. If the angle selective detector 26 responds, namely in case of a single channel detector with reaching of the angle defined by the sharpness of the maximum, then the cell 11 has to be further swiveled spilled by this angle w in order to assume the zero position, wherein the test beam 14 is reflected into itself in said zero position. However also a detector 26 highly angle resolving by itself can be employed, approximately like the detector described in the commonly owned German patent application 19637131.7 of September 12 1996 with a conoscopic lens

system; or a multi-channel detector in substantially more simple construction form, wherein the channels of the detector are stimulated depending on the momentary angle position. The wavelength of the light beam 14 falling from the source 13 to the cell 11 can be varied for amplifying transmission modulations caused by interferences.

The angle calibration can be performed based on the conoscopic principal in case of a fully stationary measurement arrangement according to figure 2 by measuring the back beam direction of a beam 14 (compare figure 1) falling under an angle, under certain angle w onto the cell 11 in order to then correct the given preadjustment of the test cell 11 relative to the optical axis of the conoscopic optics in the amount of several aviation degrees, approximately by way of a mechanical fine adjustment. The very fine adjustment gender can later still be performed by a numerical collection of the measurement values. The cell 11 is transilluminated by a bundle of in each case parallel elementary beams 14, 14', 14", wherein the parallel elementary beams 14, 14', 14" converged in the measurement spot on the cell 11, for the conoscopic measurement at the test cell 11 according to

figure 2, wherein the optical axis of the uniformly aligned liquid crystal layer assumes the edge tilt angle t relative to the in the substrate surfaces, which carry the orientation layer. This one goal of beams can be derived from an extended diffuse radiating source (which source when also illuminates and transilluminates the surroundings of the momentary interesting measured spots on the cell 11); or the bundle of beams is generated by way of optical lens system or mirror system directly. The elementary measurement beams 15,15', 15" exiting weakened depending on the angle from the cell 11 according to the conoscopic principle are transformed by a lens 30 such that the distances of the convergence points of the elementary measurement beams 15, 15', 15" from the optical axis 31 of the line 30 are unknown function of the angle of incidence of the light w in air. A so-called interference figure is then generated as an intensity distribution in the rear focal plane 33 of the lens 30, wherein the intensity of each face element corresponds to the intensity of a measurement elementary beam 15,15', 15" in the interference figure, wherein the measurement elementary beam 15,15', 15" transilluminates the cell 11 under the angle w. Thus the generated intensity distribution in the rear focal plane 33 in the

drawings plane after corresponding consideration of the functional dependency between angle of incidence w and distance from the optical axis 31 corresponds to that intensity distribution, which intensity distribution is measured during the bodily rotation according to figure 1. This functional dependency between the distance from the optical axis 31 and the angle of incidence w in air is in most cases linear with a usual construction over conoscopic lens system, however this is not necessary, a dependency according to the tangent of the angle of incidence w can be realized in a much simpler way and this nonlinear dependency can then be numerically compensated in the computations.

The position of the pseudo symmetry axis 34 shifted out of the zero point is entered for the measured example of the transmission course A(w) according to figure 2 for purposes of orientation. This intensity course A(w) can be measured for example by a detector 16 shiftable along the rear lens focal plane 33 with a small opening, or also by a (possibly reduced or demagnified) projection onto a one or two-dimensional array of detectors possibly in the form of a CCD -- line or, respectively, face camera, such as

known from the conoscopic method.

The cell transmission A(w), that is the remaining intensity of the beam in the measurement beam 15 after the cell 11, is depending on the angle of incidence of the beam w onto the cell 11 amongst other based on the double reflection features in the liquid crystal air. The correspondingly intensity modulated measurement beam 15 leads thus to an angle dependent stimulation A(w) of an optronic detector 16. The sequence of measured intensity values A(w) of the optronic detector 16 coordinated to the individual angle values w shows a course 17 = A(w) based on very short periodic interference features by multiple reflections at the glass air transitions with an intensive beard like fraying (at 27 in figure 1 and in figure 3, not considered in figure 2), wherein the course 17 = A(w) creates a noisy impression, even though in fact only periodically modulations of very different period length have been superposed onto each other however without through noise components, as shows a Fourier analysis. Said measured course A(w) is overall stored in the computer 19 and is optionally offered (as considered in figure 1) on a display 18.

The angle dependent modulated curve 22' = A'(w) or, respectively, 22"=A"(w) of the transmission modulations is calculated for given parameters after the measurement in the computer 19 based on a pregiven mathematical model 20 for the behavior of the cell 11 (under neglecting of the high frequency oscillations 27 out of the measurement course determined by the distance of the outer glass -- air -- transitions). In case of a presence of a thick testing cell 11 (typically thicker than 20 micrometers), the calculation of the transmission curve 22'= A'(w) can be limited to a 2x2 matrix method, because already a sufficiently significant modulation occurs based on the features of the double reflection in a thick cell 11. Significant effects of double refraction modulation are in contrast missing in case of thin cell 11, and for this reason further effects are now taken into consideration for the calculated curve 22"=A"(w), such as in particular modulations by multiple reflections in the liquid crystal layer. The corresponding curve 22"=A"(w) is calculated by way of a complex 4x4 matrix method, which complex 4x4 matrix method then exactly reproduces the effects derived from the birefringence, by superposing the two effects to each other in the

mathematical model 20. The period of the oscillations by birefringence is relatively large in case of realistic parameters d for the thickness of the liquid crystal layer and t for the edge tilt angle; the period of the oscillations depending on the irradiation angle caused by interfering multiple reflections is relatively small compared with the period of oscillations by birefringence, compare figure 3.

The adaptation of the calculated curve 22" in figure 3 to the actual course 17 is instilled not optimum; thus the position of the extrema (the phase position) does not agree sufficiently. Advantageously further parameters in addition to the effects of the multiple reflections in the liquid crystal layer and their thickness d are taken into consideration in the model 20 according to a further development of the present invention" for a better adaptation of the calculated curve 22" to the measured course 17. Such further parameters (b or, respectively, e in figure 1) are in particular in each case the thickness and the index of reflection of the orientation layers and/or the initially already recited transparent electrodes. These electrodes are applied directly onto the glass interior faces. The Orient station layers costing the edge tilt angle are

disposed on the glass interior faces, that is between the electrodes and the liquid crystal layer. The orientation layers stand therefore in the direct contact with the liquid crystal layer; the electrodes are disposed between an orientation layer and the cell glass. The principally very interfering since high frequency transmission modulations, which are generated by outer glass air transitions, remain completely out of consideration however in the model 20 for the calculation of the curve 22 = A(w) and thus in connection with the adaptation of the curve by simply not considering any glass in the model 20.

Matrix sets can be taken for the model calculations of the angle dependent curve courses 22', 22" (figure 1, figure 3) wherein such matrix sets have been derived by Woehler et al. in Journal of the Optical Society of America (A), Optics and Image Science, volume 5, No. 9, September 1988, pp. 1554 -- 1557. The angle dependent transmission curve 22' = A'(w) course by pure double reflection appearances in liquid crystals in case of thick cell 11 is structured mathematically less complex and can therefore already be calculated through the set up of a simpler 2x2 matrix method requiring

comparatively less numeric computing expenditure. The transmission 22" to = A(w) through a very thin test cell 11 can then also be exactly calculated with the 4x4 matrix method illustrated in the reference Woehler depending on the layer thickness d of the liquid crystal layer and depending on the tears angle t, namely under consideration of also the modulations caused by the multiple reflections in the liquid crystal layer in addition to the birefringence appearances, wherein the modulations are depending predominantly on the thickness d of the liquid crystal layer. It is symbolically simplified taken into consideration in figure 1 that has already recited then advantageously also further influence parameters such as in particular with respect to the transparent electrodes e and/or the orientation layer b are taken into consideration in this more complex model 20 in order to obtain a better adaptation of the calculated curve 22" to the actual course 17. The taking into consideration of the electrode e and/or of the orientation layer b in addition to the modulations by multiple reflections in the liquid crystal layer does not lead to an impermissibly long time requirement for the iterative calculations because of the rising of six free variables, if initially only in each case the layer thickness or the index of reflection of the further layers

are employed for adaptation, which is permissible, since these layers comprise the iso-tropic (and consequently not to drive infringement) materials ITO or, respectively, poly-imide.

Advantageously, initially the measured course 17 = a(w) is presented on a display in the realize station of a measurement apparatus working according to the present invention. Already some typical errors occurring during production or during the measurement are recognizable for an experienced practitioner. Then the indices of refraction of the liquid crystal material employed in the cell 11 are read in from a data bank or are manually entered for the curve calculation A'(w) or A"(w). This calculation is performed iteratively and automatically in order to finely present the curve 22' fitted best to the measured course 17 in its course and on the same scale. However in a practical situation the calculation A'(w) with the quicker running 2x2 matrix method is performed initially in order to calculate only the transmission curve 22' based on the double refraction. A sufficient agreement can be achieved thereby already, if the cell 11 is not too thin, if thus multiple reflections do not yet dominate. On the other hand the

calculation is repeated with the 4x4 matrix method. The calculations A"(w) are also here repeated so many times with different inputs for the free cell parameters `thickness` 23 =d and/or (tilt) `angle` 24= t and possibly additionally with the recited additional parameters with variations repeated, until again an optimum adaptation" of the now calculated curve 22" is accomplished relative to the actually measured course 17.

This desired result can be achieved automatically running in the computer 19 with one of the usual iterative computer programs possibly on the basis of mean square error minimization. These parameters readable in the result at the setting member 25 now as actual starting values are then the searched for information about the cell 11, since the information are decisive for the optical behavior.

According to the present invention thus not any longer the pseudo symmetry angle 34 (figure 2, figure 3) shifted from the coordinated zero point is determined in the transmission course 17 = A(w) depending on the irradiation angle w for determining the tilt angle t on the orientation layer in

a liquid crystal cell 11; instead the angle dependent modulations of the transmission curves A'(w) or, respectively, A" are calculated over the irradiation angle w based on a mathematical cell model 20 derived from the birefringent properties and -- for adaptation in case of thin cells 11 -- also at least derived from the multiple reflections in the liquid crystal material of the cell 11. Thereby the method is immediately applicable to very thin cells 11 taken directly out of a production line. The free computing parameters are in particular the thickness d of the liquid crystal layer in the cell 11 and the (edge-) tilt angle t on the orientation layer at the cell glass interior faces in case of non-helical or, respectively, its average tilt angle in case of helical, liquid crystal texture in the cell 11; and if required also in each case the layer thickness and the index of refraction of the transparent electrodes e and of the orientation layers b. The parameters entered into the actually performed model calculations are the searched characteristic values of the cell 11, if those parameters are finally such that in the course of automatically performed iterative calculations and that an optimum quantitative agreement of the calculating curve 17 with the measured course 22' or 22" results. Since now also no symmetry properties have to be any longer evaluated in

the course of the functions A(w), therefore the invention method is not limited to small values of the tilt angle t on the orientation layer for, respectively, to small average tilt angles. The strong oscillations 27 occurring during the measurement just in this region of small values in case of thin cells 11, which strong oscillations 27 substantially interfere with and hinder a geometric evaluation of a course 17 = A(w) measured at a very thin cell 11, now do not any longer interfere or hinder, since the strong oscillations are not contained in the adapted the calculated model curve 22' or, respectively, 22'', since the causes of the strong oscillations 27 based on glass interferences are intentionally ignored just for that reason in the mathematical model.